3.3 Determining the Air Quality Benefits of Clean Energy

Policy Description and Objective

Summary

Meeting energy demand through clean energy sources can reduce emissions from fossil-fueled generators and provide many environmental and economic benefits. Some states are estimating emission reductions from their clean energy programs and incorporating those reductions into documentation for air quality planning efforts, energy planning, and clean energy program results.

States are demonstrating a number of methods to quantify the emission reductions from clean energy policies. Approaches most useful to policymakers are cost-effective, rigorous, and address relevant emission market issues.

Quantifying the precise environmental impact of a particular clean energy project can be challenging. To determine how clean energy affects air emissions, states first estimate how much generation would be displaced at which power plants. Then they can pinpoint the type and quantity of emissions that are avoided as a result of using clean energy sources. There are many opportunities and strategies for developing adequate quantification methods, depending on the purpose and scope of the clean energy program or policy.

Several states are assessing the potential for clean energy to help meet air quality requirements within their State Implementation Plans (SIPs). A SIP is the official plan a state submits to the U.S. Environmental Protection Agency (EPA) that details how the state will attain or maintain the national ambient air quality standards. States are using a variety of approaches to estimate emissions benefits, based on the characteristics of their energy resources. These relatively new efforts are identifying opportunities to overcome traditional barriers to quantification, namely complexity and cost. Recent efforts are beginning to form the "best practices" for quantifying the air quality benefits of clean energy resources.

Integrating energy efficiency and renewable energy in air quality planning offers states many opportunities and strategies to estimate emission reductions from clean energy programs.

Objective

States are estimating emission reductions from clean energy programs for a number of purposes, including:

- Incorporating emission reductions in air quality planning documents.
- Evaluating the benefits of energy programs, such as renewable portfolio standards (RPS) and public benefits funds (PBFs), and in designing new programs. (See Section 4.2, *Public Benefits Funds for Energy Efficiency*, Section 5.1, *Renewable Portfolio Standards*, and Section 5.2, *Public Benefits Funds for State Clean Energy Supply Programs*.)
- Complying with legislative requirements for reporting the effectiveness of energy programs.
- Standardizing the methods used by energy market participants who are calculating emission reductions.

Benefits

There are many benefits to calculating the emission reductions of clean energy. These efforts:

- *Add New Options for Environmental Solutions.* If an agency gains information about the air quality benefits of clean energy, the agency can choose clean energy solutions from among a list of options designed to improve the environment.
- *Potentially Reduce Compliance Costs*. Knowing the benefits and costs of alternative clean energy solutions allows an agency to better rank these programs to achieve the greatest benefits for the least

costs. This analysis can help enable an agency to determine the best way to design its programs to comply with both existing and prospective regulations.

- *Help Agencies Choose the Best Investment.* For a particular clean energy program, an agency can use information about emission reductions to determine the best investment opportunities.

States Are Determining the Air Quality Benefits of Clean Energy

Agencies in several states are working with EPA to develop methods for quantifying air emission reductions from clean energy policies and projects. States such as Texas and Wisconsin, states in the Western Regional Air Partnership (WRAP), as well as states in the Northeast have developed estimation methods appropriate for several objectives, including incorporating clean energy into air quality planning, providing comprehensive cost/benefit analyses, meeting legislative reporting requirements, and ensuring that clean energy measures are consistent with existing regulations.

- *Incorporating Clean Energy into Air Quality Planning*. State and local air quality districts are increasingly seeking emission reductions from clean energy in their plans to achieve ambient air quality standards. Air quality plans that include the impacts of energy efficiency and renewable energy are more comprehensive than plans that ignore these resources. In addition, these resources can provide cost-effective emission reductions for regions that are attempting to attain air quality standards. In some areas, the air quality benefits may not occur unless they are clearly linked to clean energy policies that are specifically added as part of the air quality planning process.

  EPA issued guidance documents in 2004 that provide clarification on how clean energy measures can fulfill the requirements of a SIP. These documents set a flexible framework for quantifying clean energy policies and address many related issues. The documents outline two approaches a state may take to include clean energy in the SIP. The first approach is to include the clean energy measure in the projected future year emission baseline. The second approach is to include the clean energy as a discrete emission reduction measure. (For more information about these guidance documents, see the *Information Resources* section on page 3-60.)

  For example, Montgomery County, Maryland, incorporated nitrogen oxide (NO_x) emission reductions associated with a renewable energy purchase into the SIP for the Washington D.C. nonattainment area and committed to retire NO_x emission allowances to ensure the emission reductions actually occur. (For more information, see *State Examples* on page 3-54.)

- *Providing Comprehensive Cost/Benefit Analyses*. Policymakers can make better decisions about air quality program design when they have complete information about the programs' costs and benefits. Different types of energy efficiency programs can result in different levels of emission reductions, and this information can guide policymakers in selecting the appropriate suite of programs for their regions. Similarly, when selecting supply-side resources, utilities and regulatory agencies need to understand the benefits of various renewable resources. For example, New Jersey disburses some of its PBFs (see Section 5.2, *Public Benefits Funds for State Clean Energy Supply Programs*) to pay for solar energy. State officials determined that the benefit of solar energy providing electricity on sunny summer days, when demand peaks and concentration levels tend to be high, justifies the cost of incentives for the photovoltaic (PV) systems.

- *Meeting Legislative Reporting Requirements*. Some regulatory agencies are under legislative mandates to periodically report on the results of their energy policies. For example, some legislatures require reporting on the cost and benefits of RPS or PBFs (see Section 4.2, *Public Benefits Funds for Energy Efficiency*, Section 5.1, *Renewable Portfolio Standards*, and Section 5.2, *Public Benefits Funds for State Clean Energy Supply Programs*), and in some cases, they require cost/benefit reports before they reauthorize the RPS or PBF. The New York State Energy Research and Development

Authority (NYSERDA) includes emission reductions as part of its reports detailing how the performance of PBFs helps achieve the state's goal to reduce environmental impacts of energy production and use.

- *Ensuring Clean Energy Measures Are Consistent with Existing Regulations*. Standardized methods for estimating emission reductions from clean energy will ensure that estimates made by different parties are accurate and comparable. They also help ensure that the estimates are consistent with other regulations such as cap and trade programs. For example, the Independent System Operator (ISO) New England's Marginal Emission Rate Analysis and the Ozone Transport Commission's (OTC's) Emission Reduction Workbook were developed so that the emission impacts of different projects and programs could be evaluated in a consistent manner (OTC 2002, ISO New England 2004).

Quantifying Air Emission Reductions from Clean Energy

Estimating the air emissions that will be avoided by clean energy programs and projects involves three key steps:

- Establishing the operating characteristics of the program or project in terms of when and how much it will reduce demand for conventional energy.
- Determining which generating units will be displaced and to what extent due to the program or project.
- Calculating the avoided emissions using the emission factors associated with the generating units.

Determining the load impact of the clean energy resource requires estimating at which times it will operate and at what levels. For example, will the energy efficiency savings be taking place on hot summer daylight hours or will it be occurring 24 hours per day, seven days a week, 52 weeks per year? Different renewable resources have different operating profiles based on the availability of, for example, wind and sunlight. Knowing the load shape of the clean energy resource is helpful in predicting which generators would most likely be backed down and, consequently, where and how many emission reductions would occur. There also may be an accounting of emissions associated with the clean energy source, such as for biomass and landfill gas.

The next step is estimating emission changes, typically by calculating the likely emission reductions based on either a model to assess which generating units will reduce generation due to the clean energy or historical trends.

- *Dispatch and Planning Models.* Dispatch models estimate the air emission effects of clean energy by identifying the marginal generating units—the units that are assumed to be displaced by the clean energy program or project. States that use this approach estimate reductions by identifying the marginal units during the hours that the clean energy resources operate and applying the expected emission rate of the units to the displaced generation. An example is the analysis performed for the Montgomery County, Maryland, wind purchase (for more information, see *State Examples* on page 3-54).

  A dispatch model is a comprehensive way to approximate plant dispatch, using software to simulate the operation of all the plants in the region. Because these models are designed to simulate all of the constraints facing power system operators, they provide realistic estimates of reduced emissions.

  Planning models are used for longer time horizons and can help discern the effect of clean energy on the construction of new plants and the retirement or modification of existing plants. For example, WRAP used the Integrated Planning Model (IPM) to analyze its renewable energy goals (for more information, see *State Examples* on page 3-54).

  Dispatch and planning models can be expensive to operate and maintain. Therefore, these models might not be an option for some uses.

- *Historic Trends Analysis.* When resources are not available to run a dispatch model, states approximate plant dispatch by looking at historical plant

How Is Electricity Dispatched?

Deciding when and how to direct power plants to operate is a complex process. As a result, calculating the air emission reductions associated with displacing some of these plants with clean energy projects is also challenging.

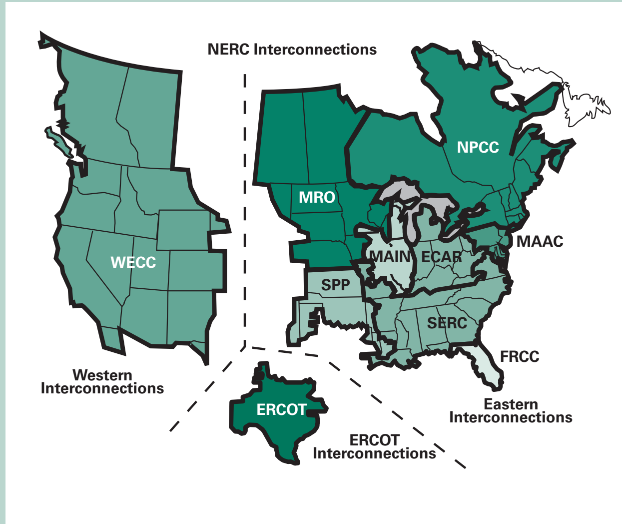
Understanding how electricity is dispatched and which power plants would be backed off at the margin by clean energy involves some key information about the U.S. electricity system. The continental United States is divided into three interconnected grids (the Eastern, Western, and Electric Reliability Council of Texas [ERCOT] Interconnections), shown in Figure 3.3.1. Within each of these grids, electricity can be imported or exported relatively easily between the numerous power control areas. However, it is difficult to transmit energy across the boundaries of these three interconnections.

The demand for electricity varies by season and by time of day. Some power plants, known as baseload units, operate almost continuously. The output of other generators rises and falls throughout the day, responding to changing electricity demand. Other generators are used as "peaking" units; these are operated only during the times of highest demand. A group of system operators across the region decides when and how to make each power plant operational or "dispatch" them according to the demand at that moment. System operators decide which power plants to dispatch next based on the cost or bid price. The power plants that are least expensive to operate are dispatched first (the baseload plants). The most expensive generating units are dispatched last (the peaking units). The fuels, generation efficiencies, control technologies, and emission rates vary greatly from plant to plant. For example, Figure 3.3.2 shows how the SO_2 and NO_x emission rates in the New York power control area vary as a function of load. Note that hydro and nuclear generators that have no air emissions meet about 7,000 megawatts (MW) of demand. To meet the need for the additional demand, system operators dispatch fossil-fired power plants that have varied NO_x and SO_2 emissions.

Other conditions also affect dispatch. Transmission constraints, when transmission lines become congested, can make it difficult to dispatch power from far away into areas of high electricity demand. Extreme weather events can decrease the ability to import or export power from neighboring areas. "Forced outages," when certain generators are temporarily not available, can also shift dispatch to other generators.

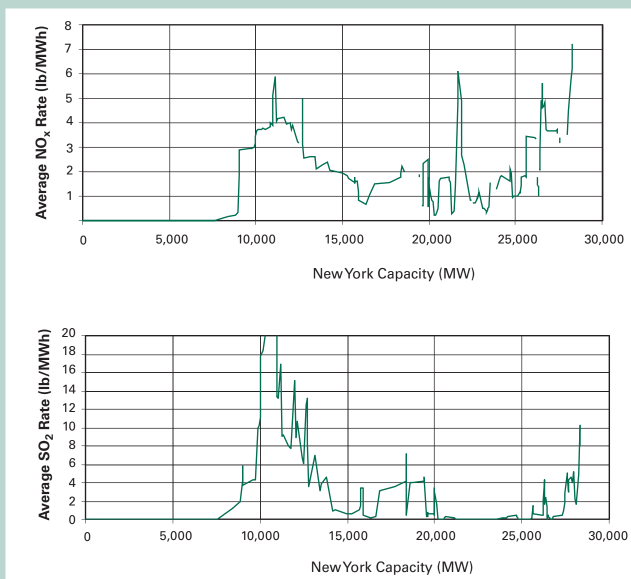
System operators must keep all these issues in mind when dispatching power plants. States can also take these issues into consideration by using dispatch models or other approaches to estimate which generators would likely reduce their output and their emissions in response to the use of clean energy.

Figure 3.3.1: Map of Interconnections



Source: NERC 2005.

Figure 3.3.2: NO_x and SO_2 Emissions by Capacity



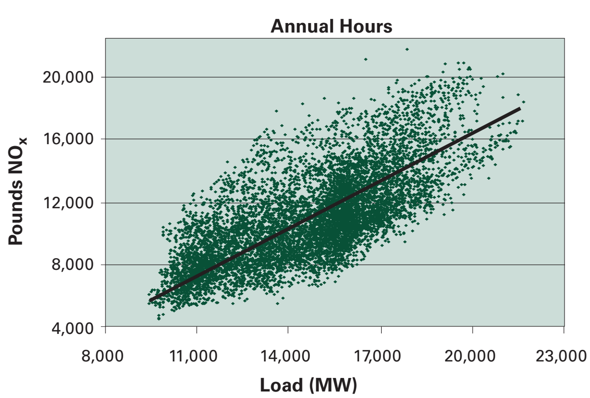
Source: Keith et al. 2002.

operations. Data on historical plant use are available from the EPA eGRID database (EPA 2005) and from the U.S. Department of Energy's (DOE's) Energy Information Administration (http://www.eia.doe.gov). Additionally, by reviewing hourly data collected by emission monitoring devices, states reconstruct how system emissions changed as loads changed during a given day or season. This approach is especially effective for assessing historical emission reductions (see Figure 3.3.3) (Keith et al. 2005). Historical analysis can also be used to project how plant emissions might be reduced in the future by clean energy.

It is possible to combine the two approaches to generate a more complete view of the power system. For example, ISO New England uses both historical information and dispatch modeling to generate its annual reports on marginal emission rates in the New England Power Pool (NEPOOL).

Finally, after considering the characteristics of clean energy projects and calculating marginal emission rates, the emission reductions can be estimated. The emission reductions are calculated by applying the emission rates of each of the electric generating units to the displaced generation at each generator.

Figure 3.3.3: Historical Emissions Data
(New England 2000)



Note: Plots of power system emissions as a function of load can be used to develop marginal emission rates during different time periods. This plot is for the New England region in 2000.

Source: Synapse Energy Economics (Date unknown).

Issues to Consider

States are developing and evaluating ways to quantify how clean energy reduces air emissions. Their efforts have highlighted a number of important issues and strategies:

- *Purpose of Quantification.* It is important to note that the proper quantification method and documentation will vary for different purposes. For example, when estimating emission reductions for use in an air quality plan (such as an SIP), a high level of rigor and comprehensive documentation are needed to meet public health and regulatory needs. To ensure that appropriate methods and documentation are used, states may contact EPA early in the process if assistance is needed. In contrast, for a report summarizing the benefits of clean energy programs, states tend to use less resource-intensive methods of quantification and documentation.
- *Prospective vs. Retrospective Analyses.* Estimates of emission reductions from both existing projects and expected new projects are useful. States have much more information about existing projects than about future projects. This information includes data about the clean energy projects and the operation of the regional power grid. With this information, states can create accurate estimates of historical emission reductions. States face more uncertainty when projecting how future clean energy projects will contribute to air quality improvements. Thus, they have found that it is important to periodically review and revise estimates related to these projects. In addition, when states perform a prospective analysis, they consider how new emission control requirements for fossil fuel generators affect their calculations. If the clean energy displaces fossil fuel generation governed by future emission control requirements, then the clean energy will have less impact on emissions in the future. For example, the analysis performed for the Texas Emission Reduction Plan updates its estimates annually and accounts for NO_x control programs imposed on the electric generators (for more information, see *State Examples* on page 3-54).

- *Power System Dispatch.* Power plants in regional electric systems are dispatched in order of increasing costs or bids. Generally, the least expensive power plants are dispatched first, and the more expensive units are directed to operate in order of cost when needed. This process is described on page 3-50, *How Is Electricity Dispatched*? Estimating dispatch is a critical and complex component to estimating emission reductions. As new methods are being demonstrated by states, new opportunities for others to use or refine the successful methods are created.
- *Energy Imports and Exports.* One of the key complexities in assessing emission reductions (either via dispatch/planning models or historical emissions analysis) lies in accounting for energy transfers between control areas. A control area is a geographic region in which most or all of the power plants are dispatched by a single set of system operators. Energy is commonly transferred among control areas via major transmission interfaces. The magnitude and pattern of energy transfers can affect the kind of emission reductions that a clean energy resource will provide. For clean energy resources located in control areas that do not import or export significant amounts of energy, energy transfers can be ignored. However, in control areas where significant amounts of energy are transferred, addressing these transactions may be an important part of the emission reduction calculations.
- *Load Pockets.* Load pockets are places within a control area where transmission constraints make it difficult to meet peak electricity loads. In a load pocket, older, less efficient generation often operates because physical constraints prevent delivery of energy from newer units. Because a clean energy resource located within a load pocket will often reduce the operation of such units, the clean energy project may have different emission impacts than other resources. Additionally, clean energy resources can reduce or delay the need for new transmission and distribution equipment. For example, for the Southwest Connecticut Clean Demand Response Pilot Project, a clean distributed generation overlay tool was envisioned to help locate ideal placement of clean technologies. The map would identify locations where technologies or applications could be most effective at addressing reliability concerns within the load pocket. It also would identify which areas would benefit most from an air quality perspective. The tool would examine the area's infrastructure, zoning, and existing developments to find areas that could be economically practical as well as technically feasible (GETF 2002).

Designing an Effective Process

This section identifies several key issues that states need to consider when quantifying emission reductions. These issues include participants, duration, evaluation, and interaction with federal policies. When designing an effective process, it is important to engage key participants, and match the purpose of the quantification with the level of rigor and cost associated with the quantification method.

Participants

- *EPA.* EPA is investigating several methods for estimating emission reductions and is working with a number of state agencies to test and compare these methods.

  EPA is working to assist states in defining potential emission reductions associated with the programs and policies outlined in this *Guide to Action* and to help states use the information to meet their environmental and energy goals. EPA is working to:

  - Identify clean energy projects and programs that may provide cost-effective emission reductions that states could capture.
  - Review methods that states can use to quantify emission reductions from clean energy and move toward best practice standards.
  - Provide states with guidance and assistance in their efforts to incorporate clean energy into air quality planning and other state initiatives.
- *DOE.* In 2004, DOE's Office of Energy Efficiency and Renewable Energy initiated pilot projects to

help states quantify the emission reductions from various clean energy programs to a level of rigor that would satisfy inclusion in air quality planning documents. These pilot projects provide the resources of DOE's contractors and national laboratories to assist states.

- *State Energy Offices.* State energy offices are involved in the design, implementation, and tracking of a variety of clean energy programs. They often track the performance of energy efficiency programs and renewable energy, and they are often required to report on these programs to legislatures. Information on emissions is an important component of energy program assessment. Data on emissions are also important to the long-term energy plans many energy offices develop.
- *State Air Pollution Control Agencies.* State air pollution control agencies are working toward including emission reductions from clean energy in air pollution control plans. This process generally starts with several case studies. State regulatory agencies also work with EPA to establish methods of quantifying emission reductions. Working with state energy office staff provides the additional expertise that may be needed for a successful process.
- *State Utility Commissions.* By involving utility commissions, states ensure that data are available for evaluating efficiency programs and the output of renewable generators. Also, coordination between utility commissions and air regulatory agencies ensures that clean energy policies are consistent with air quality regulations.
- *State Legislatures.* Lawmakers in many states have adopted clean energy programs as a way to achieve multiple goals, including air quality improvements. Based on information from utility commissions, air regulatory agencies, and energy offices, lawmakers have adopted clean energy goals, such as RPS and PBFs, designed specifically to achieve air emission reductions.
- *Electricity Market Participants.* Several market participants have an interest in quantifying emission reductions from clean energy, including energy service providers, renewable energy developers, and end users. These participants often work with state agencies to quantify and document emission reductions from clean energy.
- *Utilities.* Utilities work with air and energy regulatory agencies to review the performance of clean energy programs and to help design programs that meet both energy and air quality goals. In particular, utilities have access to information on energy generation and use that is critical to program design and review.
- *Other Researchers.* Nonprofit organizations and other groups are also evaluating how to quantify emission reductions from clean energy. Groups involved include the National Renewable Energy Laboratory (NREL), World Resources Institute (WRI), Lawrence Berkeley National Laboratory (LBNL), the National Association of Regulatory Utility Commissioners (NARUC), WRAP, and State and Territorial Air Pollution Program Administrators (STAPPA).

Timing and Duration

Electric power systems change over time. New plants and transmission lines are added and old ones are retired. These changes affect system emissions. There are two ways to address these changes when estimating emission reductions from clean energy projects. First, emission reductions can be quantified for the short term—for example, three to five years—and then updated as the power system changes. Second, states and others can make long-term projections of emission reductions using assumptions about how the power system is likely to change over time. Of course, long-term projections will only be as good as the assumptions on which they are based, so it is prudent to review these projections periodically and revise them if market conditions diverge from important assumptions.

Clean energy programs such as RPS and PBFs also include uncertainties. States quantifying the emission reductions from an RPS, for example, will include an assumption about the technologies that would generate the new renewable energy. Further, policymakers may change the RPS after several years, perhaps increasing or decreasing the target energy levels. For both of these reasons, states periodically review projections of emission reductions from clean energy programs and make adjustments when necessary.

Evaluation

States periodically evaluate their clean energy programs to ensure that predicted emission reductions are being realized. For example, a state might assume that an RPS will result in 100,000 megawatt-hours (MWh) of new renewable energy generation each year. The state would then verify this assumption once the data become available. To accomplish this, states typically use established measurement and verification (M&V) techniques for clean energy. Energy production is measured either at the point of generation (gross generation) or at the connection point to the electric grid (accounting for any in-plant use). There are various standard protocols to evaluate the performance of energy efficiency projects, including some that use customers' energy consumption records.

Understanding the types of clean energy program evaluations that will be needed helps a state determine the appropriate methods to perform both the initial prospective estimates of emission reductions and the retrospective evaluation of actual emission reductions. For example, legislatively mandated policies may require more rigorous evaluation than voluntary efforts. Policies that address energy supply may require different data to be collected and evaluated than policies that address energy demand. Considering the need for future evaluation ensures that the initial estimates will be sufficient to provide a basis for evaluation.

Interaction with Federal Policies

Some states are working with EPA to include clean energy as an emission reduction measure in a SIP. EPA released several documents that address how to accomplish this. These documents are: *Guidance on State Implementation Plan (SIP) Credits for Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures* and *Incorporating Emerging and Voluntary Measures in a State Implementation Plan* (for more information, see *Information Resources* on page 3-60).

States quantifying emission reductions from energy efficiency and renewable energy consider the effects of any applicable cap and trade programs. Under these programs, air regulatory agencies cap total emissions within a region. Allowances are allocated to generators. Generators may buy and sell allowances, but they must hold one allowance for each ton of pollution emitted. Typically, the level of the cap declines over time to meet air quality objectives. Subsequently, generators need to adopt more emission control strategies over time.

Because emission allowances can be traded in a cap and trade area, it is important to consider two main issues: how much clean energy is implicitly assumed to occur in the design of the cap and trade program and how many allowances need to be retired to ensure the emission reductions from clean energy programs actually occur and endure.

State Examples

The Texas Emission Reduction Plan

In 2001, the 77th Texas Legislature passed Senate Bill 5 (S.B.5), the Texas Emissions Reduction Plan, calling for energy efficiency and reduced electricity consumption to help the state comply with U.S. Clean Air Act standards. Forty-one urban and surrounding counties were required to:

- Implement all cost-effective energy efficiency measures to reduce electric consumption by existing facilities.
- Adopt a goal of reducing electric consumption by 5% a year for five years, beginning January 1, 2002.
- Report annually to the State Energy Conservation Office.

In 2002 and 2003, the Texas Commission on Environmental Quality (TCEQ) revised SIPs for the Houston-Galveston and Dallas-Ft. Worth areas. Early energy savings and emission reductions estimates relied on assumptions about the communities' level of commitment to the 5% per year goal. Projects eligible for inclusion in the SIP include efficiency and renewable projects such as: building code upgrades, energy efficiency retrofits, renewable energy installations, and green power purchases.

The TCEQ worked with EPA, ERCOT, and Texas A&M University's Energy Systems Laboratory (ESL) to develop a methodology for quantifying the NO_x emission reductions associated with energy savings from clean energy projects. The methodology was used to prepare emission reduction estimates for each power plant in the ERCOT region. The groups then submitted these estimates to relevant counties. EPA's eGRID provided much of the data about electricity production, source, fuel mix, and emissions. This information was used to estimate demand and emission reductions in Texas (Haberl et al. 2003).

The purpose of the air emission reduction estimates was to include the NO_x emission reductions as discrete emission reduction measures in the air quality planning process for ground level ozone. The estimate is a prospective analysis. The analytic approach was based on historic trends analysis of operational data with modifications based on future emission controls, planned plant shutdowns, and planned new plants. The few imports and exports outside the ERCOT were ignored. The historic trends analysis was not able to accommodate explicit consideration of load pockets. Ultimately, the Houston area reductions were not included in the SIP due to a local cap and trade program.

Web site:
http://www.tnrcc.state.tx.us/oprd/sips/mar2003dfw.html#revision

Western Regional Air Partnership

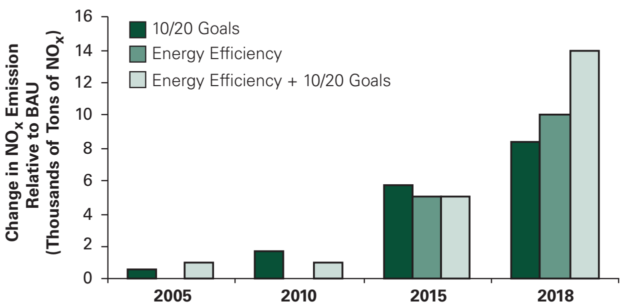
In 1996, the Grand Canyon Visibility Transport Commission (GCVTC) issued a report saying states that contribute to regional haze in the West should incorporate 10% renewable energy into their resource mix by 2005 and 20% by 2015.

In 1997, western states and tribes established WRAP to help implement the GCVTC's recommendations. In 1999, EPA's Regional Haze Rule required nine western states to prepare SIPs addressing regional haze. The rule specifically allowed those states to develop and implement regional approaches to improve visibility. Five states in the Transport Region (Arizona, New Mexico, Oregon, Utah, and Wyoming) chose to implement this regional approach and submitted their SIPs in December 2003.

As part of its SIP, each state lists policies and programs at the regional and state levels that will help achieve the 10 and 20% goals (often indicated as the 10/20 goals). These programs include RPS, PBFs, renewable energy purchases, net metering (when excess electricity produced by an electricity customer will spin the electricity meter backwards), green power marketing, as well as tax credits and other financial incentives. In addition, states may pursue clean energy initiatives that are not included in the SIP submissions.

The Air Pollution Prevention forum of WRAP commissioned a detailed study of the impacts of policies that achieve the 10/20 goals. When both the 10/20 goals and the energy efficiency recommendations are implemented, NO_x emissions are expected to be reduced by about 14,000 tons in 2018 (see Figure 3.3.4), and carbon dioxide (CO_2) emissions by about 56 million metric tons. These impacts represent about a 2% reduction of NO_x emissions and about a 14% reduction of CO_2 emissions. The net avoided cost savings is expected to increase to about $1.8 billion in 2018. Annual electricity production costs through 2022 will be reduced by about $751 million.

Figure 3.3.4: Estimated NO_x Reductions from Energy Efficiency/Renewable Energy (EE/RE)



Source: WRAP 2003.

Although energy efficiency and renewable energy reduce conventional electric generation requirements, they do not necessarily yield SO_2 reductions. In this case, the regional SO_2 cap and trade program was assumed to be in effect. As such, the renewable energy and energy efficiency was projected to reduce the cost of complying with the cap and trade program and reduce allowance prices rather than reduce emissions significantly. In this context, increasing the use of EE/RE reduces the costs of complying with the SO_2 milestones in the Annex to the Regional Haze Rule developed by WRAP (APPF 2002, WRAP 2003).

The purpose of the air emission reduction estimates was to determine the how much the GCVTC's recommendations would help the region achieve its regional haze goals. The estimates are a prospective analysis. The analytic approach was based on a planning model. Imports and exports within the western grid were considered. The large regional planning model analysis was not able to accommodate explicit consideration of load pockets. Cap and trade program analysis was an integral part of the planning model.

Web site:
http://www.wrapair.org/forums/ap2/

Analyzing Efficiency Programs in Wisconsin

The Wisconsin Department of Administration (DOA) recently funded an analysis of the emission impacts of the state's energy efficiency programs. Recognizing that efficiency programs have multiple impacts (i.e., energy savings, demand reductions, and emission reductions), the DOA wanted to obtain better information about how programs could be targeted toward certain objectives.

To analyze how efficiency programs affected air emissions, the evaluation team used EPA continuous emission monitoring data on historical plant operations and emissions to estimate which generating plants were "on the margin" during different time periods. These are the plants scheduled to become operational next—when the less expensive plants are running at full capacity.

In this case, the DOA identified the units "on the margin" for given hours. These units are important in calculations because they are the units that are displaced by energy efficiency or clean energy.

The DOA developed emissions factors for the marginal generating units for different time periods (e.g., peak and off-peak hours during winter and summer). The DOA then used these factors to analyze the effects of different energy efficiency programs.

The study found that the marginal units' emission rates tend to be higher during off-peak hours than on-peak hours, particularly winter off-peak hours (see Figure 3.3.5). This suggests that energy savings in off-peak hours produce the largest emissions savings in Wisconsin (Erickson et al. 2004). This is valuable information, given that savings during peak hours are considered to be most valuable to the power system (because peak savings reduce demand during high-demand periods). With this information, policymakers are better able to refine the state's efficiency programs to meet different objectives as the power system evolves.

Figure 3.3.5: Marginal Emission Rates in Wisconsin

Season and Hour	Pounds /MWh			Pounds /GWh	Percent of Yearly Value			
	NO_X	SO_X	CO_2	Mercury	NO_X	SO_X	CO_2	Mercury
Yearly	5.7	12.2	2.215	0.0489				
Broad Peak Scenario								
Winter Peak	5.9	13.9	2.027	0.0427	104%	114%	91%	87%
Winter Off-peak	5.8	14.5	2.287	0.0536	102%	119%	103%	110%
Summer Peak	4.6	9.8	1.788	0.0346	81%	80%	81%	71%
Summer Off-peak	5.4	11.1	2.233	0.0524	95%	91%	101%	107%
Narrow Peak Scenario								
Winter Peak	No Winter Peak Hours							
Winter Off-peak	5.1	11.0	2.078	0.0461	39%	90%	94%	94%
Summer Peak	2.9	6.0	1.476	0.0181	51%	49%	67%	37%
Summer Off-peak	5.4	11.2	2.073	0.0431	95%	92%	94%	88%

Source: Erickson et al. 2004.

The purpose of this analysis was to update emission reduction factors being used to evaluate the PBF program in Wisconsin. The analytic approach as a load-duration curve dispatch model. The estimates are a retrospective analysis. The analysis includes consideration of dispatch within the Mid-Atlantic Interconnected Network (MAIN) and Midwest Reliability Organization (MRO) (previously named Mid-Continent Area Power Pool [MAPP]) North American Electric Reliability Council regions (see Figure 3.3.1 on page 3-50). The model did not explicitly define load pockets. The affect of cap and trade systems was not included in the emission reduction estimates.

Web site:
http://www.doa.state.wi.us/docs_view2.asp?docid=2404

Performance Contracting in Shreveport, Louisiana

As part of its SIP revision under sections 110 and 116 of the Clean Air Act and in support of control measures for the purpose of attaining and maintaining the 8-hour ozone standard, the Louisiana Department of Environmental Quality (DEQ) submitted an Early Action Compact SIP for the Shreveport area to EPA on December 28, 2004. The SIP included the emission reductions expected to be achieved from performance contracting at particular municipal buildings in Shreveport. The performance contract is expected to save the city 9,121 MWh of electricity per year and achieve NO_x emission reductions of 0.041 tons per ozone season-day.

The city arrived at this figure after employing several different methods of determining the emissions avoided through its programs (Chambers et al. 2005). EPA Region 6 published proposed approval of this SIP revision in the *Federal Register* at 70 FR 25000, May 12, 2005, and published final approval at 70 FR 48880, August 22, 2005.

The purpose of this emission reduction analysis was to include the emission reductions within its SIP. The analytic approach was a comparison of results from an economic dispatch model and two historic trends analysis. The analysis is retrospective (year 2000). The economic dispatch analysis included consideration of dispatch within two power control areas that provide electricity in the Shreveport area. The model did not explicitly define load pockets. The affect of cap and trade systems was not included in the emission reduction estimates.

Wind Power Purchase in Montgomery County, Maryland

Montgomery County, Maryland, committed to purchase 5% of its municipal electricity from wind power through renewable energy credits (RECs). It incorporated the emission reductions for ground-level ozone in the SIP for the Washington D.C. metropolitan area.

The county made the business case for purchasing the renewable energy by demonstrating that the energy savings realized by very low cost energy efficiency measures would offset the incremental cost of the renewable energy purchase. The county also demonstrated that the emission reductions from the renewable energy purchase were less expensive on a dollar per ton basis than other measures.

The expected emission reduction for the 30,000 MWh per year of renewable energy is estimated to be 0.05 tons of NO_x per day during the ozone season. To arrive at this estimate, the county employed a dispatch model covering the electricity grid in the western part of PJM Interconnection, which is the regional transmission organization that coordinates the dispatch of wholesale electricity in the region.

As mentioned previously, the state of Maryland committed to retire the NO_x allowances associated with the claimed emission reductions (i.e., to permanently remove the allowances from the market and prevent their use). This is how the county met the requirements of the SIP measure (MWCOG 2004). EPA Region 3 published final approval of this revision to the SIP in the *Federal Register* (70 FR 24987, May 12, 2005).

The purpose of this quantification procedure was to provide NO_x emission reduction figures to be used in the Washington, D.C. SIP. The analytic approach was based on an economic dispatch model. The analysis is prospective. The economic dispatch analysis included consideration of dispatch within the power control area of the region. The model did not explicitly define load pockets. Although cap and trade systems were not included in the emission reduction estimates, the retirement of emission allowances equivalent to the estimated emission reductions were included in the SIP.

Web site:
http://www.mwcog.org/environment/air/SIP/default.asp

On the Horizon

Some state air quality officials are beginning to express interest in environmental dispatch of electricity generators. This concept would alter the way electricity generators are dispatched from a purely economic basis to one that incorporates some consideration of environmental emissions into the dispatch order. Emissions analysis coupled with air quality modeling could provide useful analytical information to help evaluate the conditions under which environmental dispatch may achieve significant benefits for the least cost. For example, if there are periods of time when the air quality is most vulnerable to additional emissions from power generation, the benefits of dispatching cleaner yet more expensive units may outweigh the additional cost. Additionally, if such conditions occur infrequently during the entire year, the overall cost increase to retail electricity customers could be negligible.

Some states are also interested in tracking emission reductions of CO_2 in addition to criteria air pollutants. The quantification methods discussed in the *Guide to Action* will be critical to these efforts. Unlike technologies to control air pollutants like NO_x and SO_2, technologies are currently not widely used to capture and control CO_2 emissions from the emission stacks of electricity generators. Therefore, for the near future, most CO_2 emission reductions will generally come from renewable energy sources and improved efficiency.

A number of states are developing voluntary CO_2 reduction goals, and a growing number of companies are developing voluntary greenhouse gas strategies. They are working with the Greenhouse Gas Protocol Initiative, states, and EPA to document their efforts. Other states are incorporating CO_2 reduction into long-term planning requirements for utilities, or requiring utilities to offset their greenhouse gas emissions from power plants with investments in renewable energy, energy efficiency, and other measures such as carbon sequestration. Several states are developing tracking programs to support such requirement and companies' voluntary tracking efforts. Table 3.3.1 briefly describes CO_2 reductions efforts under way.

Table 3.3.1: Existing Policies to Reduce CO_2 Emissions

Policy/Description	For More Information
Tracking Progress Toward State Goals. New York and New Jersey have both adopted goals for greenhouse gas reductions, as have groups of states in New England and on the West Coast.	• New Jersey Department of Environmental Protection (DEP), *New Jersey Sustainability Greenhouse Gas Action Plan,* April 2000. http://www.state.nj.us/dep/dsr/gcc/gcc.htm • *New York State Energy Plan,* 2002. http://www.nyserda.org • New England Governors and Eastern Canadian Premiers (NEG/ECP): *Climate Change Action Plan: 2001,* August, 2001.
CO_2 Offset Requirements. Massachusetts and New Hampshire require large, fossil-fueled power plants to offset a portion of their CO_2 emissions. Massachusetts, Oregon, and Washington require new power plants to offset emissions.	• MA DEP, Emission Standards for Power Plants (310 CMR 7.29). • *New Hampshire Clean Power Act* (HB 284) approved May, 2002. • Oregon Climate Trust. http://www.climatetrust.org
CO_2 Adders in Resource Planning. The California Public Utility Commission (CPUC) has developed an "imputed" cost for greenhouse gas emissions for use in utility planning. In addition, several utilities (PG&E, Avista, Portland General Electric, Xcel, Idaho Power, and PacifiCorp) have voluntarily used CO_2 cost adders in resource planning.	• CPUC, Decision 04-12-048, December 16, 2004. http://www.cpuc.ca.gov/PUBLISHED/AGENDA_DECISION/42314.HTM
Voluntary Quantification Efforts. Many companies have begun tracking their annual greenhouse gas emissions and taking steps to reduce emissions. These companies are using a variety of methods for calculating emission reductions.	• EPA's Climate Leaders program offers inventory guidance for companies that voluntarily participate in the program. http://www.epa.gov/climateleaders • Information on these efforts and tracking protocols used is available from the Greenhouse Gas Protocol Initiative. http://www.ghgprotocol.org • Information in voluntary efforts in California is available from the California Climate Action Registry. http://www.climateregistry.org

What States Can Do

To begin capturing the benefits of clean energy programs, states can identify ways to use emission reduction data, quantify emission reductions, identify programs and policies that provide reductions, and document reduction estimates.

Action Steps for States

- *Begin Identifying Ways to Use the Air Emission Reductions That Result from Clean Energy Programs.* Emission reduction data can be included in air quality plans and used in evaluating existing clean energy programs, developing new clean energy programs, and preparing reports to legislatures and the public. These different uses may require different quantification and documentation methods; thus, it is important to identify possible uses before developing emission reduction data.
- *Identify Clean Energy Programs That May Provide Emission Reductions.* Many states have a range of clean energy policies (e.g., energy efficiency goals, RPS, PBFs, and appliance standards) that may result in emission reductions. Other programs may also provide emission reductions. These include enhanced building codes, green power purchases, net metering, tax incentives, and other financial incentives. The information resources on page 3-60

present data on clean energy programs that states have focused on to date.

- *Quantify Emission Reductions from Clean Energy Projects and Programs.* States can use a number of methods to quantify emission reductions from clean energy, including simple approaches that are based on estimates of average fossil generation emission rates. More resource-intensive approaches are based on system dispatch modeling. The previous section on quantifying emission reductions provides a general overview of the key issues involved in quantification. The information resources provided below document a number of quantification efforts. States can talk with EPA to help identify the appropriate methods. As discussed, the proper quantification method and documentation requirements will vary, depending on the purpose of the effort.
- *Document Emission Reduction Estimates.* Documenting emission reduction estimates in as much detail as possible is an important step. When developing emission reduction estimates for an air quality plan, contact EPA early in the process to discuss methods and documentation requirements (see EPA's *Incorporating Emerging and Voluntary Measures in a State Implementation Plan* [EPA 2004] for guidance). States are encouraged to seek information from other states and disseminate emission reduction studies widely to facilitate the movement toward standardized best practices. Documenting and publishing reports on emission reduction quantification efforts is one way to advance the art of quantification methods.

Information Resources

The resources cited as follows provide more information about methods of quantifying emission reductions and the types of programs states are targeting.

EPA Guidance

Title/Description	URL Address
Guidance on State Implementation Plan (SIP) Credits for Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures. EPA Office of Air and Radiation, August 2004. In this document, EPA provides detailed information on quantifying emission reductions from electric-sector programs.	http://www.epa.gov/ttn/oarpg/t1/meta/m25362.html
Incorporating Emerging and Voluntary Measures in a State Implementation Plan. EPA Office of Air and Radiation, September 2004. In this guidance document, EPA lays out a basic methodology for approving nontraditional measures in a SIP through notice-and-comment rulemaking.	http://www.epa.gov/ttn/caaa/t1/meta/m8507.html
Integration Pilots: Improving Air Quality through Energy Efficiency & Renewable Energy Technologies. EPA Concept Paper, August 26, 2004. This paper describes a DOE/EPA initiative pilot initiative demonstrating how states can use energy efficiency and renewable energy technologies to improve air quality while addressing energy goals.	http://www.eere.energy.gov/regions/mid-atlantic/cleanenergy_pres.html
Incorporating Bundled Emissions Reduction Measures in a State Implementation Plan. August 2005. This guidance document describes how states can identify individual voluntary and emerging measures and "bundle" them in a single SIP submission. For SIP evaluation purposes, EPA considers the performance of the entire bundle (the sum of the emission reductions from all the measures in the bundle), not the effectiveness of any individual measure.	http://www.epa.gov/ttn/oarpg/t1/meta/m10885.html

Information About States

Title/Description	URL Address
Comparison of Methods for Estimating the NO_x Emission Impacts of Energy Efficiency and Renewable Energy Projects: Shreveport, Louisiana Case Study. Chambers, A. et. al. NREL, revised July 2005, NREL/TP-710-37721. This report describes three methods for estimating emission reductions from electric-sector programs and provides a quantitative comparison of the methods.	http://www.nrel.gov/docs/fy05osti/37721.pdf
Estimating Seasonal and Peak Environmental Emission Factors—Final Report. Prepared by PA Governmental Services for the Wisconsin DOA, May 2004. This report summarizes work done in Wisconsin to evaluate the air emissions avoided by energy efficiency programs.	http://www.doa.state.wi.us/docs_view2.asp?docid=2404
Prospective Environmental Report for Clipper Wind Power. Prepared by the Resource Systems Group, Inc. for Clipper Wind Power under contract with Environmental Resources Trust, April 2003. This report quantifies the air emissions reduced by the operation of a wind plant located in the Mid-Atlantic United States.	http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/wpa/sips_model.pdf
Renewable Energy and Energy Efficiency as Pollution Prevention Strategies for Regional Haze. Prepared by the air pollution prevention forum for the Western Regional Air Partnership, April 2003. This report summarizes the renewable energy and energy efficiency goals adopted in several western states and projects the emission reductions that would result from the attainment of the goals.	http://www.wrapair.org/forums/ap2/documents/WRAP_AP2_Policy.doc

General Articles About Quantifying Emission Reductions

Title/Description	URL Address
2003 NEPOOL Marginal Emission Rate Analysis. Prepared for the NEPOOL Environmental Planning Committee, December 2004. ISO New England performs system modeling each year to estimate system marginal emission rates.	http://www.iso-ne.com/genrtion_resrcs/reports/emission/index.html
Emerging Tools for Assessing Air Pollutant Emission Reductions from Energy Efficiency and Clean Energy. Global Environment & Technology Foundation, January 31, 2005. This report presents a comparison of emission modeling tools that are currently under development.	http://www.4cleanair.org/EmissionsModelingPhaseIIFinal.pdf
Estimating Carbon Emissions Avoided by Electricity Generation and Efficiency Projects: A Standardized Method (MAGPWR). LBNL, LBNL-46063, September 1999. This report describes a spreadsheet model developed for estimating emission reductions from electric-sector programs.	http://eetd.lbl.gov/EA/EMS/reports/46063.pdf
Methods for Estimating Emissions Avoided by Renewable Energy and Energy Efficiency. Prepared for EPA's State and Local Capacity Building Branch, available in July 2005. This paper assesses quantification methods based on dispatch analysis and historical emissions and provides a quantitative comparison of the two approaches.	http://www.synapse-energy.com
National Assessment of Emissions Reduction of Photovoltaic Power Systems. Prepared for EPA's Air Pollution Prevention and Control Division by Connors, S. et al. This paper lays out a method of estimating emissions avoided by small PV systems based on the analysis of historical emissions data.	http://esd.mit.edu/symposium/pdfs/papers/connors.pdf (provides information about this article)

Tools and Analyses

Title/Description	URL Address
Clean Air and Climate Protection Software (CACPS). The State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (STAPPA/ALAPCO) have developed a software tool designed for use in creating emission reduction plans targeting greenhouse gas emissions and air pollution.	http://www.4cleanair.org/InnovationDetails.asp?innoid=1
ECalc. The eCalc tool was developed to assess emission reductions from energy efficiency in Texas.	http://ecalc.tamu.edu/
Energy Efficiency/Renewable Energy Impact In The Texas Emissions Reduction Plan (TERP). The Energy Systems Lab conducts this annual report of the energy savings and NO_x reductions resulting from the statewide adoption of the Texas Building Energy Performance Standards and from energy code compliance in new residential construction in 41 Texas counties.	Summary (Volume I): http://energysystems.tamu.edu/sb5/documents/tceq-report-2-14-2005-vol-I.pdf Technical (Volume 2): http://energysystems.tamu.edu/sb5/documents/tceq-report-2-14-2005-Vol-II.pdf Appendix (Volume 3): http://energysystems.tamu.edu/sb5/documents/tceq-report-2-14-2005-III.pdf
OTC Emission Reduction Workbook 2.1, November 12, 2002. The OTC developed a spreadsheet tool, based on system dispatch modeling, for assessing emission reductions from EE/RE in the northeastern United States.	http://www.otcair.org/document.asp?fview=Report Excel File: http://www.otcair.org/download.asp?FID=68&Fcat=Documents&Fview=Reports&Ffile=OTC%20Workbook%20version%202.1.xls Description and User's Manual: http://www.otcair.org/download.asp?FID=69&Fcat=Documents&Fview=Reports&Ffile=Workbook%202.1%20Manual.pdf
Power System Dispatch Models. Models that can be used to assess displaced emissions include: • GE MAPPS (GE Strategic Energy Consulting) • IPM (ICF Consulting) • NEMS (U.S. Energy Information Administration) • PROSYM (Global Energy Decisions)	MAPPS: http://www.mapps.l-3com.com/L3_MAPPS/Products_and_Services/Power_Systems_and_Simulation/Power_Solutions/ppsim.shtml IPM: http://www.icfconsulting.com/Markets/Energy/energy-modeling.asp#2 NEMS: http://www.eia.doe.gov/oiaf/aeo/overview/index.html PROSYM: http://www.globalenergy.com/pi-market-analytics.asp

References

Title/Description	URL Address
APPF. 2002. Final Draft Report on Energy Efficiency and Renewable Energy. Prepared by the Air Pollution Prevention Forum for WRAP. December.	http://www.wrapair.org/forums/ap2/documents/draft/Final_Draft_Report-AP2EE-RE.pdf
Chambers, A., D.M. Kline, L. Vimmerstedt, A. Diem, D. Dismukes, and D. Mesyanzhinov. 2005. Comparison of Methods for Estimating the NO_x Emission Impacts of Energy Efficiency and Renewable Energy Projects: Shreveport, Louisiana Case Study. NREL/TP-710-37721. Revised July 2005. NREL.	http://www.nrel.gov/docs/fy05osti/37721.pdf
EPA. 2004. Incorporating Emerging and Voluntary Measures in a State Implementation Plan. EPA's Office of Air and Radiation. September.	http://www.epa.gov/ttn/caaa/t1/meta/m8507.html
EPA. 2005. eGRID-Emissions and Generation Resource Integrated Database Web site. Accessed July 2005.	http://www.epa.gov/cleanenergy/egrid/index.htm
Erickson, J., C. Best, D. Sumi, B. Ward, B. Zent, and K. Hausker. 2004. Estimating Seasonal and Peak Environmental Emission Factors—Final Report. Prepared by PA Governmental Services for the Wisconsin DOA. May 21.	http://www.doa.state.wi.us/docs_view2.asp?docid=2404
GETF. 2002. Southwestern Connecticut Clean Demand Response Pilot Project, Phase I Report. Prepared for the OTC by the Global Environment & Technology Foundation. November.	http://www.opm.state.ct.us/swct/SWCTPhase1-Report-Final.pdf
Haberl, J., C. Culp, B. Yazdani, T. Fitzpatrick, J. Bryant, and D. Turner. 2003. Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP), Volume I—Summary Report. Annual Report to TCEQ, September 2003–August 2004. ESL-TR-04/12-01. ESL.	http://energysystems.tamu.edu/sb5/documents/tceq-report-2-14-2005-vol-I.pdf
ISO New England. 2004. 2003 NEPOOL Marginal Emission Rate Analysis. Prepared for the NEPOOL Environmental Planning Committee. December.	http://www.iso-ne.com/genrtion_resrcs/reports/emission/index.html
Keith, G. 2005. Methods for Estimating Emissions Avoided by Renewable Energy and Energy Efficiency. Prepared for EPA's State and Local Programs. Capacity Building Branch. July 14.	http://dep.state.ct.us/air2/siprac/2005/emissionreduction.pdf
Keith, G., D. White, and B. Biewald. 2002. The OTC Emission Reduction Workbook 2.1: Description and Users' Manual. Volume 2.1. Prepared for the OTC by Synapse Energy Economics, Inc. November 12.	http://www.otcair.org/download.asp?FID=69&Fcat=Documents&Fview=Reports&Ffile=Workbook%202.1%20Manual.pdf
MWCOG. 2004. Plan to Improve Air Quality in the Washington, D.C-MD-VA Region. Appendix J. Metropolitan Washington Air Quality Committee. February 9.	http://www.mwcog.org/uploads/committee-documents/yFZaVg20040217142920.pdf.
NERC. 2005. Regional Reliability Councils. North American Electric Reliability Council Web site. Accessed July 2005.	http://www.nerc.com/regional/NERC_Interconnections_color.jpg
OTC. 2002. Emission Reduction Workbook 2.1, November 12, 2002. OTC. November 12.	http://www.otcair.org/document.asp?fview=Report
Synapse Energy Economics. Date unknown. Unpublished emissions data, Synapse Energy Economics, Inc., Cambridge, MA.	N.A.
WRAP. 2003. Renewable Energy and Energy Efficiency as Pollution Prevention Strategies for Regional Haze. Prepared by the Air Pollution Prevention Forum for WRAP. April.	http://www.wrapair.org/forums/ap2/docs.html